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Maturity and Nonstationarity of Convertible Bond Beta: Theory and Evidence

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Bond Beta: Theory and Evidence

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Abstract

This paper has considered the return generating process of convertible bonds. An analytical model of the return generating processes of convertible bonds was developed. The model combines the capital asset pricing model and the Black-Scholes option pricing model to produce empirically testable assertions concerning the effect of changes in time on systematic risk estimates. An empirical method is described which allows identification of systematic changes in the time pattern of convertible security returns. The results of the variable mean response random coefficient regression model with time trend indicate that systematic risk for a significant number of convertible securities decline over time.

I. Introduction

According to the Sharpe (1964), Lintner (1965) and Mossin (1966) capital asset pricing model (CAPM), an investor's objective is to maximize his expected utility conditional on his wealth endowment and risk preferences. In the one-period CAPM, systematic risk (β_i) portrays the risk-return parameter of interest for portfolio construction. In this general equilibrium framework, the investor is faced with the problem of estimating the systematic risk of particular assets. Historically, the *ex post* returns on particular assets have been regressed on an *ex post* estimate of the return on the market to obtain estimates of systematic risk. It should be emphasized that a time series estimate of systematic risk is not a direct result of the CAPM. Instead, the time series estimate implicitly assumes a stationary non-stochastic systematic risk parameter. The purpose of this research is to suggest theoretical and empirical results which question the validity of the assumption of stationary non-stochastic systematic risk paremeters for a subset of all risky assets, convertible bonds.

In the next section, a review of convertible security valuation and random coefficient models are presented as background. In the third section, an analytical framework for derivation of empirically testable hypotheses is summarized. Section IV derives the four-step Hildreth-Houck estimator for the variable mean response random coefficient regression model with time trend. In Section V, the results of the empirical tests are presented. In Section VI, a section summarizing and concluding this work is offered.

II. Review of Convertible Security Valuation and Applications of Random Coefficient Models

Convertible security valuation models have evolved with advances in finance theory. The earliest models of convertible security valuation were graphical representations (e.g., Brigham (1966)) and equations with numerous exogeneously specified variables (e.g., Baumol, Malkiel and Quandt (1966) and Poensgen (1965, 1966). In more recent developments, the option pricing methodology has been employed by Ingersoll (1977) and Brennan and Schwartz (1977) to consider the valuation problem facing investors. The common theme of all these valuation methodologies relies on the observation that a convertible security is a combination of a straight debt value and a premium paid for the conversion privilege. In the following section, this decomposition of convertible security value will be employed to consider the nature of the return generating process of a convertible security.

A second line of finance research has investigated the empirical attributes of the return generating processes of various risky assets. With the introduction of the market model, the risk-return structure of equity securities was investigated by numerous authors. In a number of endeavors, beta stationarity was the major research question. Blume (1971, 1975) and Klemkosky and Martin (1975) have considered the tendency of beta coefficient estimates to regress toward their mean. In a seminal work on the random coefficient model, Fabozzi and Francis (1978) found a significant number of equity securities that displayed return generating processes that may be characterized as possessing a random coefficient. Following Fabozzi and Francis (1978), the use of the random coefficient model to

describe the observable returns of risky assets has been considered by a series of authors (e.g., Sunder (1980), Lee and Chen (1982), and Alexander, Benson and Eger (1982)). This work extends the random coefficient regression model studies to convertible bonds. In the next section, the Black-Scholes (1973) option pricing model is blended with the capital asset pricing model (CAPM) to derive empirically testable assertions for convertible bonds.

III. The Model and Its Analysis

Using continuous-time contingent-claim analysis, Ingersoll [1977] has derived a pricing model for a non-callable, coupon-bearing, convertible bond in Theorem V of his paper as follows:

$$G(V,\tau;B,C,q) = D(V,\tau;B,C) + W(qV,\tau;B) \tag{1}$$

where G = the value of a non-callable, coupon bearing convertible bond;

D = the value of an ordinary bond;

W = the value of a warrant;

V = the market value of the firm;

B = the principal on the ordinary bond;

C = coupon payment;

τ = the time to maturity;

$q \equiv n/(n+N)$, the dilution factor when there are N shares of common stock outstanding and the convertible issue can be exchanged, in aggregate, for n shares.

Equation (1) states that a non-callable, coupon-bearing convertible bond is equal in value to a portfolio consisting of an ordinary bond with the same coupon, principal, and maturity plus a warrant entitling

the owners to purchase the same fraction of the equity of the firm upon an exercise payment equal to the principal on the bond.

Given the equilibrium valuation relationship in (1), the relationship between the systematic risks of the three assets can be easily expressed as

$$\beta_G = \frac{D}{G}\beta_D + \frac{W}{G}\beta_W, \tag{2}$$

where the systematic risk of a non-callable, coupon bearing, convertible bond is simply the value-weighted average of the systematic risks of an ordinary coupon bond and a warrant respectively. Recently, Galai and Schneller [1978] have derived the value of a warrant as follows:

$$W = C(1-q) \tag{3}$$

where C is the premium of a call option which has the same characteristics as the warrant. Eq. (3) states that the value of a warrant is equal to the value of the call adjusted by the dilution effect. Since the return on the warrant is always (1-q) the return on the call option, the systematic risk of the warrant must equal the systematic risk of the call option.

$$\beta_W = \beta_C \tag{4}$$

Furthermore, Galai and Masulis [1976] have linked the systematic risk of a call option with the systematic risk of the underlying stock as follows:

$$\beta_C = \eta\beta_S \tag{5}$$

where η is the elasticity of call premium with respect to the value of the underlying stock.

Substituting (4) and (5) into (2) yields

$$\beta_G = \alpha\beta_D + (1-\alpha)\eta\beta_S \tag{6}$$

where $\alpha = \frac{D}{G}$. The systematic risk of a non-callable, coupon bearing, convertible bond is a weighted average of the systematic risk of the straight coupon bond and the systematic risk of the stock multiplied by an elasticity term. Even if the systematic risk of the stock is stationary, the systematic risk of the convertible bond will generally be non-stationary because of the presence of the elasticity term. Therefore, a non-stationary instead of a stationary market model should be used to estimate the systematic risk of convertible bond.

Furthermore, as shown by Ingersoll and Galai and Masulis that

$$\begin{gathered} \frac{\partial D}{\partial \tau} < 0,\ \frac{\partial G}{\partial \tau} > 0,\ \frac{\partial W}{\partial \tau} > 0 \\ \frac{\partial \beta_D}{\partial \tau} \gtreqless 0, \text{ and } \frac{\partial \beta_S}{\partial \tau} < 0, \end{gathered} \tag{7}$$

the sign of $\frac{\partial \beta_G}{\partial \tau}$ is indeterminate. To help understand the effect of a change in time τ on the systematic risk of the convertible bond, further examination of the nature of the convertible bond is necessary.

Since most convertible bonds are issued with a call provision, in what follows we will bring this call feature into our analysis. As Ingersoll [1977] has proven his Theorem VII, whenever it is optimal to voluntarily convert a non-callable convertible bond, it will also be optimal to convert a callable, convertible bond which is otherwise

identical. Therefore, the preceding analysis can be applied to callable convertible bonds also. Furthermore, Ingersoll has shown that if the perfect markets, no dividends, and constant conversion terms assumptions are valid, then a callable convertible will never be converted except at maturity or call. If voluntary conversion is allowed, Ingersoll has shown that voluntary conversion of a convertible bond will occur only if the current dividend yield on the stock exceeds the current yield on the bond. Thus, a callable convertible bond will behave more like the stock if the current dividend yield on the stock is close to or exceeds the current yield on the bond; otherwise, it will behave more like the straight bond. In the former case, the effect of a change in time on the second term in (6) dominates the effect of a change in time on the first term. Therefore, $\partial\beta_G/\partial\tau < 0$. In the latter case, $\partial\beta_G/\partial\tau \gtreqless 0$. However, Weinstein [1983] has shown that $\partial\beta_D/\partial\tau > 0$ if coupon rate on the bond is greater than the risk-free rate and the value of the firm exceeds the value of a risk-free bond with the same promised payments as the corporate bond.[1] When the convertible bond behaves more like the straight bond, it is more likely that $\partial\beta_G/\partial\tau > 0$, given Weinstein's results.

IV. Research Method

A general linear regression model with random coefficient is presented in equation (8) below:

$$y(t) = \sum_{\lambda=1}^{\Lambda} \beta_\lambda(t)X_\lambda(t) \tag{8}$$

where

$y(t) \equiv$ the $t^{\underline{th}}$ observation of the dependent variable;

$x_\lambda(t) \equiv$ the $t^{\underline{th}}$ observation of the λ independent variable;

$\beta_\lambda(t) \equiv$ the random coefficient of the λ independent variable;

$t = 1, \ldots, T$ (Singh, Nagar, Choudhry and Raj (1976), p. 342).

The random coefficient is modeled in equation (9) as follows:

$$\beta_\lambda(t) = \overline{\beta}_\lambda + \overline{\alpha}_\lambda f_\lambda(t) + \varepsilon_\lambda(t) \tag{9}$$

where

$f_\lambda(t)$ is a function of time, t;

$\overline{\beta}_\lambda$ is the constant slope through time;

$\overline{\alpha}_\lambda$ is the coefficient of the time trend of the random coefficient $\beta_\lambda(t)$;

$\varepsilon_\lambda(t)$ is a random component associated with $\beta_\lambda(t)$.

This model of the random coefficient can be introduced into equation (8) to obtain equation (10):

$$y(t) = \sum_{\lambda=1}^{\Lambda} \overline{\beta}_\lambda x_\lambda(t) + \sum_{\lambda=1}^{\Lambda} \overline{\alpha}_\lambda f_\lambda(t) x_\lambda(t) + w_t \tag{10}$$

where

$$w_t = \sum_{\lambda=1}^{\Lambda} \varepsilon_\lambda(t) x_\lambda(t).$$

To consider the time trend of convertible security systematic risk, an adaptation of the familiar market model will be estimated. The specific form of this model in terms of market model is presented in equation (11):[2]

$$R_i(t) = \overline{\beta}_1 + \overline{\beta}_2 R_m(t) + \overline{\alpha}_1 t + \overline{\alpha}_2 t R_m(t) + w_t \tag{11}$$

where

$R_i(t)$ is the rates of return on the ith security;

$R_m(t)$ is the market rates of return;

t is the time trend.

Equation (11) is transformed into matrix notation in equation (12) below:

$$\underline{R} = \underline{Z\beta} + \underline{w} \tag{12}$$

where

$$\underline{R} = \begin{bmatrix} R_i(1) \\ R_i(2) \\ \cdot \\ \cdot \\ \cdot \\ R_i(T) \end{bmatrix};$$

$$\underline{Z} = \begin{bmatrix} 1 & R_m(1) & 1 & R_m(1) \\ 1 & R_m(2) & 2 & 2R_m(2) \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ 1 & R_m(T) & T & TR_m(T) \end{bmatrix} = \left[\underline{R}_m \;\vdots\; t\underline{R}_m \right];$$

$$\underline{w} = \begin{bmatrix} w_1 \\ \cdot \\ \cdot \\ \cdot \\ w_T \end{bmatrix}; \quad \underline{R}_m = \begin{bmatrix} 1 & R_m(1) \\ 1 & R_m(2) \\ \cdot & \cdot \\ \cdot & \cdot \\ \cdot & \cdot \\ 1 & R_m(T) \end{bmatrix};$$

$$\underline{\beta} = \begin{bmatrix} \bar{\beta}_1 \\ \bar{\beta}_2 \\ \bar{\alpha}_1 \\ \bar{\alpha}_2 \end{bmatrix}.$$

To estimate equation (12), a four-step modified Hildreth-Houck estimator is employed. First, an estimate of $\underline{w}$ is obtained in equation (13).

$$\underline{\hat{w}} = \underline{M}\ \underline{R} \tag{13}$$

where

$$\underline{M} = \underline{I} - \underline{Z}(\underline{Z}'\underline{Z})^{-1}\underline{Z}'.$$

Next, we consider the matrices of squared elements of $\underline{w}$, $\underline{M}$ and $\underline{R}_M$ in equation (14). (The dot, ., indicates that the elements are squared.)

$$\underline{\dot{\hat{w}}} = \underline{\dot{M}}\ \underline{\dot{R}_M \sigma} + \underline{\eta} = \underline{G\sigma} + \underline{\eta} \tag{14}$$

where

$$\underline{\sigma} = \begin{bmatrix} \sigma_{11} \\ \sigma_{22} \end{bmatrix} ;$$

$$\underline{\eta} = \underline{\dot{\hat{w}}} - E\dot{\hat{w}}.$$

With the second use of least squares procedures, equation (15) is obtained:

$$\hat{\sigma} = (\underline{G}'G)^{-1}\underline{G}'\underline{\dot{\hat{w}}} \tag{15}$$

With equation (15) an estimator of σ_{11} and σ_{22} can be used to develop an estimate of Φ. Next, equation (16) can be shown to be a direct result of the assumptions required to derive equation (14) (Singh, Nagar, Choudhry and Raj (1976), p. 352).

$$E\underline{\eta}\underline{\eta}' = 2\underline{\phi} \tag{16}$$

where

$\underline{\phi} = M\underline{\Phi}M$;

$\dot{\underline{\phi}}$ = is the squared elements of $\underline{\phi}$.

Given equation (16), a second estimator of σ can be derived from equation (17).

$$\underline{\sigma}^* = (\underline{G}'\dot{\underline{\phi}}^{-1}\underline{G})^{-1}G'\dot{\underline{\phi}}^{-1}\hat{\dot{w}} \qquad (17)$$

In the fourth stage, $\dot{\underline{\sigma}}^*$ is employed to develop an estimate of $\underline{\Phi}$, $\underline{\Phi}^*$. This result permits a final estimate of $\underline{\beta}$ in equation (18).

$$\underline{\beta}^* = (\underline{Z}'\Phi^{*-1}\underline{Z})^{-1}\underline{Z}'\Phi^{*-1}\underline{R}. \qquad (18)$$

Equation (18)'s estimate of $\bar{\beta}_1$, $\bar{\beta}_2$, $\bar{\alpha}_1$ and $\bar{\alpha}_2$ can be tested for statistical significance in the traditional fashion employing simple t-tests. In the next section, results of the four-step modified Hildreth-Houck estimate of the variable mean response random coefficient model with time trend are reported.

V. Empirical Evidence

V.1 Data and Model

This section presents the results of the model employing a four-step Hildreth-Houck estimator of a random coefficient model with time trend. First, the sample of convertible securities is described. Then, the random coefficient results are summarized.

Sample selection followed a two-step process. First, the population of convertible bonds was defined to be those convertible securities which were outstanding from 1976 through 1979, inclusive. This criterion yields 347 convertible bonds. Then, 100 convertible bonds

were randomly selected. The second step required each of the previously selected convertible securities to be readily available in the data collection sources. Three convertible bonds were not listed in the Commercial and Financial Chronicle for the time period selected. Thus, the final sample contains 97 convertible bonds.

Once the sample of convertible bonds was established, monthly price data was assembled from the Commericial and Financial Chronicle. Upon collection of monthly prices, monthly returns (adjusted for cash distributions) were created. These monthly returns are the dependent variable in the random coefficient models. The independent variable in the random coefficient models was a broadly based value-weighted index. Monthly returns and market values for U.S. government bonds, Standard and Poor's High Grade bonds and the CRSP equity securities were combined to obtain the value-weighted index. With these dependent and independent variables, both the ordinary least squares (OLS) regression and the random coefficient regression model are estimated in terms of equations (19) and (20) respectively.[3]

$$R_{jt} = \alpha_j + \beta_j R_{mt} + \varepsilon_{jt} \tag{19}$$

$$R_{jt} = \alpha_j + \beta_{jt} R_{mt} + \varepsilon_{jt} \tag{20}$$

where

$$\beta_{jt} = \beta + \gamma t + \eta_t$$

V.2 Hypothesis to be Tested

As discussed in Section III, a convertible bond will behave more like the stock if the current dividend yield on the stock exceeds the

current yield on the bond. Therefore, $\partial\beta_G/\partial\tau < 0$. The coefficient of γ in (20) is hypothesized to be negative. When the current dividend yield on the stock is less than the current yield on the bond, the convertible bond will behave more like the straight bond. If coupon rate on the bond is greater than the risk-free rate and the value of the firm exceeds the value of a risk-free bond with the same promised payments as the corporate bond, $\partial\beta_G/\partial\tau > 0$. Therefore, the coefficient of γ in (20) is hypothesized to be positive. For other cases, the coefficient of γ is hypothesized to be negative.

V.3 Empirical Results

Table 1 reports the results. There are 20 convertible bonds that behave like stock because their dividend yields are greater than corresponding current yields. Among them, 14 convertible bonds exhibit negative γ coefficient as hypothesized, while six exhibit positive γ coefficient (only 1 exhibits significant positive γ coefficient). In our sample, there is no single convertible bond whose coupon rate is greater than the average risk-free rate in 1979, thus the coefficients of γ for 77 convertible bonds whose dividend yield are less than corresponding current yield are hypothesized to be negative or zero. As shown in Table 1, there are 77 convertible bonds which behave more like the straight bonds. Among them, 42 exhibit significant negative γ and 28 insignificant. However, there are 33 convertible bonds which exhibit positive γ coefficient, but only 10 show statistical significance.

Table 1

	Behave Like Stock	Behave Like Bond
Significant positive γ:	1	10
Insignificant positive γ:	5	23
Significant negative γ:	5	14
Insignificant negative γ:	9	28
Total	20	77

Results of equation (19) are presented in Appendix A and results of equation (20) are presented in Appendix B. In Appendix A, the market model results suggest that convertible security systematic risk is slightly below the systematic risk of the entire market (β_{cv} = .8104). In, similar fashion to estimate of equity security systematic risk with monthly data, a significant proportion of estimated systematic risk parameters are different from zero at the 5% α-level (65%). Summary results of Appendix B are listed in Table 2.

Table 2

	Intercept α	Slope β	Slope (time trend) γ	Random Coefficient Parameter
1%	3	17	9	10
5%	9	13	14	4
10%	7	9	7	6
Insignificant	78	58	67	75

There are 30 out of 97 convertible bonds with significant γ-coefficient estimates under 10 percent significance level. Eleven of these 30 convertible bonds exhibit a positive estimated γ-coefficient. The company names of these 30 convertible bonds and their coupon rates are listed in Appendix C. These results imply that maturity can be important in estimating the beta coefficients of convertible bonds. In twenty out of 97 firms, the random coefficient parameter is significant

at the 10% α-level. This evidence suggests that a fixed coefficient ordinary least squares estimate of a convertible bond systematic risk may exhibit significant levels of measurement error. Thus, the assumption of convertible bond systematic risk stationarity may not be descriptively accurate for a significant subset of convertible securities.

VI. Summary and Conclusions

This paper has considered the return generating process of convertible bonds. An analytical model of the return generating processes of convertible bonds was developed. The model combines the capital asset pricing model and the Black-Scholes option pricing model to produce empirically testable assertions concerning the effect of changes in time on systematic risk estimates. An empirical method is described which allows identification of systematic changes in the time pattern of convertible security returns. The results of the variable mean response random coefficient regression model with time trend indicate that systematic risk for a significant number of convertible securities decline over time. Based upon the information of dividend yield, corporate, average risk-free rate and the sign of estimated γ, 97 convertible bonds are classified into either behaving like stock or behaving like bond.

These results also suggest that an ordinary least squares estimate of convertible security systematic risk may produce imprecise estimates. This work has documented a time trend for a sizable proportion of the convertible bonds in the sample. When considering the application of the market model for systematic risk estimation with convertible bonds, the addition of a time parameter may provide a statistically significant explanatory variable for a number of convertible securities.

FOOTNOTES

[1]This seems like a reasonable assumption. Using Compustat data, Weinstein [1983] has found that the value of the firm exceeds the value of debt for most firms.

[2]The research method presented in Section IV is a direct application of Singh, Nagar, Choudhry and Raj's (1976) generalized random coefficient regression model.

[3]The models defined in equations (19) and (20) are only special cases of the model defined in equation (11).

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Appendix A

Firm No.	$\hat{\beta}_{cv}$	t-Ratios	Firm No.	$\hat{\beta}_{cv}$	t-Ratios
1	.3961	1.6551	49	.6085	2.5133
2	.3147	1.9170	50	1.6815	4.1239
3	1.3149	3.6084	51	1.1194	3.9333
4	1.1692	4.8539	52	2.0807	4.4046
5	.2666	.5302	53	1.8747	4.8548
6	1.3371	2.7469	54	.8957	2.8386
7	.3125	1.8939	55	.5238	2.1599
8	.1210	.6402	56	.3470	1.8634
9	.7936	2.9380	57	1.9962	6.1222
10	1.7173	6.6268	58	1.3589	4.4058
11	1.2831	4.0382	59	1.3468	7.0830
12	.9439	2.6467	60	.6284	2.7656
13	.3616	1.4437	61	.8089	3.1310
14	.0359	.4440	62	.3455	.8592
15	1.0482	4.7417	63	-.0024	-.0153
16	-.0123	-.0243	64	-.0383	-.1296
17	.5891	1.4670	65	1.3502	3.9078
18	1.6729	6.4439	66	1.0702	4.1610
19	1.5633	7.1408	67	1.1109	2.0264
20	1.0280	2.7122	68	1.7908	4.8421
21	1.5840	3.8184	69	1.1032	3.0677
22	1.1827	2.3926	70	-.1296	-.5206
23	.7757	4.2917	71	.7944	2.9919
24	.4540	1.4837	72	.0028	.0455
25	.9874	2.1197	73	1.0490	2.5239
26	1.7375	3.3726	74	.4553	2.0036
27	1.3290	4.4478	75	2.2769	5.6050
28	1.0903	3.5842	76	.4892	.3506
29	.5911	2.9236	77	.7988	3.9746
30	-.0333	-1.1627	78	2.3835	4.7978
31	.8135	4.2518	79	.6355	2.4601
32	1.9556	4.3754	80	1.2346	4.2985
33	1.3837	5.2057	81	.0161	.0533
34	.9282	2.6588	82	1.0863	2.1100
35	.5174	3.1373	83	.3108	1.7336
36	-.3749	-.9838	84	.6651	3.2102
37	.2572	.844	85	.7192	2.9253
38	1.7200	7.0970	86	.0798	.3618
39	.6407	3.5915	87	.6300	2.2484
40	.9713	4.0741	88	.8517	2.3795
41	1.1557	3.0787	89	-.0313	-.0916
42	.0748	.2218	90	.7300	2.4382
43	.2171	.6990	91	.0125	.0490
44	.7181	3.2082	92	.0869	.2113
45	1.1389	4.0429	93	1.1136	2.6644
46	-.0111	-.0046	94	.5310	2.6318
47	.6769	2.6398	95	.0730	.4183
48	.2398	.8280	96	.5201	3.1255
			97	.2253	.5246
			$\bar{\beta}_{cv}$	.8104	

Appendix B

	α	β	γ	σ_{ε}^{2}	σ_{β}^{2}
1	-.0032 (-.6908)	1.4592 (2.3285)**	-.0296 (-1.7527)*	.0011 (3.9026)**	-.1146 (-.2615)
2	.0019 (.6758)	2.0170 (4.9422)***	-.0498 (-4.3734)***	.0003 (3.2978)***	.1317 (.8354)
3	-.0032 (-.4142)	1.8003 (1.6951)*	-.0135 (-.4658)	.0028 (2.2711)**	.1237 (.0648)
4	-.0025 (-.5854)	2.4003 (3.2684)***	-.0362 (-1.6831)*	.0006 (2.6737)***	1.4487 (4.3077)***
5	-.0149 (-1.9423)*	-.0740 (-.0705)	-.0004 (-.0140)	.0059 (2.8430)***	-1.9910 (-.6210)
6	.0040 (.4030)	.5352 (.3730)	.0238 (.5957)	.0044 (2.5636)***	1.3491 (.5162)
7	.0015 (.4475)	-.3902 (-.8584)	.0204 (1.6280)	.0005 (3.2440)***	.0761 (.3362)
8	.0058 (1.5615)	.6853 (1.2280)	-.0213 (-1.3576)	.0006 (2.8167)***	.3503 (1.1275)
9	.0108 (1.9644)**	.8499 (1.0737)	-.0048 (-.2164)	.0013 (3.5829)***	.3897 (.6782)
10	.0013 (.2613)	2.0735 (2.6533)***	-.0227 (-1.0168)	.0009 (2.6037)***	1.0764 (2.0079)**
11	-.0247 (-3.9024)***	.5640 (1.3520)	.0052 (.3140)	.0024 (4.0126)***	-.8419 (-.9219)
12	.0025 (.3574)	2.4116 (2.4071)**	-.0455 (-1.6351)	.0021 (3.0191)***	.6305 (.5782)
13	.0063 (1.4443)	2.4973 (4.3418)***	-.0618 (-4.0037)***	.0010 (3.2324)***	-.1681 (-.3512)
14	.0016 (1.0338)	.0699 (.3508)	-.0006 (-.1068)	.0002 (3.5451)***	-.0422 (-.6486)
15	-.0010 (-.2336)	1.1583 (1.7198)*	-.0054 (-.2836)	.0008 (2.6651)***	.6328 (1.4422)*
16	.0155 (1.4203)	-.7140 (-.8254)	.0077 (1.2450)	.0057 (1.7815)**	-2.1868 (-.4439)

Appendix B (cont'd.)

	α	β	γ	σ_{ε}^{2}	σ_{β}^{2}
17	.0152 (1.9678)**	-1.5284 (-1.3921)	.0596 (1.9602)**	.0027 (3.2166)***	.6272 (.4937)
18	.0019 (.3704)	.7382 (.9809)	.0266 (1.2692)	.0012 (2.6680)***	.4217 (.6280)
19	.0037 (.8696)	.3329 (.5881)	.0349 (2.3012)**	.0010 (4.3713)***	-.1613 (-.4710)
20	.0040 (.5669)	3.4711 (3.7799)***	-.0680 (-2.7652)***	.0028 (3.0912)***	-.6358 (-.4560)
21	.0100 (1.2286)	2.5315 (1.9738)**	-.0340 (-.9190)	.0022 (2.4520)***	3.4476 (2.5146)***
22	.0014 (.1414)	2.6851 (1.8773)*	-.0458 (-1.1560)	.0044 (3.1883)***	1.2008 (.5634)
23	.0023 (.9107)	.6503 (1.2422)	-.0010 (-.0614)	.0002 (.8417)	1.1395 (3.5650)***
24	.0067 (1.1932)	.2659 (.2818)	.0001 (.0048)	.0011 (2.3654)***	2.0606 (2.8846)***
25	.0073 (.7753)	2.0925 (1.5810)	-.0330 (-.9067)	.0041 (2.6138)***	.5987 (.2496)
26	.0206 (2.0026)**	1.0827 (.6817)	.0145 (.3209)	.0041 (1.8164)**	3.6666 (1.0440)
27	-.0097 (-1.5815)	1.5751 (1.8135)*	-.0068 (-.2842)	.0017 (3.7696)***	.3359 (.4840)
28	-.0021 (-.3960)	2.3770 (2.6633)***	-.0411 (-1.5927)	.0010 (1.9297)**	1.7350 (2.1151)**
29	-.0031 (-.7540)	1.3671 (2.3524)**	-.0245 (-1.5189)	.0007 (4.5962)***	.1989 (.8157)
30	.0099 (1.7322)*	1.1803 (1.4927)	-.0350 (-1.6203)	.0016 (2.8679)***	.0767 (.0920)
31	.0010 (.2575)	1.1958 (2.2093)**	-.0019 (-.8002)	.0007 (3.8483)***	.0571 (.2002)
32	.0168 (1.8536)*	2.7768 (2.3156)**	-.0253 (-.7869)	.0044 (2.2426)**	-.7417 (-.2467)

Appendix B (cont'd.)

	α	β	γ	σ_{ε}^{2}	σ_{β}^{2}
33	.0031	1.5518	-.0048	.0014	.1582
	(.5716)	(2.0231)**	(-.2287)	(4.4654)***	(.3281)
34	.0081	.5746	.0137	.0018	1.7536
	(1.1972)	(.5416)	(.4540)	(1.1087)	(.7065)
35	.0022	.2025	.0077	.0005	.1797
	(.6491)	(.4213)	(.5764)	(2.8226)***	(.7004)
36	.0087	1.8107	-.0639	.0025	.4171
	(1.1829)	(1.7500)*	(-2.2409)**	(2.6120)***	(.2884)
37	.0047	1.3127	-.0296	.0019	-.1180
	(.7701)	(1.5754)	(-1.3092)	(2.2431)**	(-.0910)
38	-.0076	2.1345	-.0114	.0011	.1581
	(-1.5315)	(3.0635)***	(-.5970)	(3.8043)***	(.3444)
39	-.0009	.9785	-.0117	.0006	.2359
	(-.2425)	(1.8532)*	(-.7958)	(2.6818)***	(.7400)
40	-.0028	.5588	.0148	.0013	-.4549
	(-.9419)	(1.1994)	(1.0810)	(3.6496)	(-.8133)
41	.0021	-.8675	.0465	.0032	-.9631
	(.3037)	(-.9764)	(1.9382)*	(4.4533)**	(-.8704)
42	.0015	2.3025	-.0637	.0021	-.2980
	(.2443)	(2.7368)***	(-2.8127)***	(3.1508)***	(-.2921)
43	.0023	-.2096	.0137	.0021	-.3247
	(.3660)	(-.2515)**	(.6103)	(3.9665)***	(-.4018)
44	-.0027	2.3949	-.0486	.0009	-.0202
	(-.6466)	(4.1900)***	(-3.1305)***	(4.5158)***	(-.0689)
45	.0125	.6307	.0155	.0013	.6220
	(2.2525)**	(.7705)	(.6760)	(2.5970)***	(.8063)
46	.0112	-.6422	.0150	.0010	.3857
	(2.3206)**	(-.9155)	(.7664)	(3.1454)***	(.7886)
47	.0021	2.2270	-.0457	.0012	.0583
	(.4243)	(3.2609)***	(-2.4462)**	(4.7918)***	(.1566)
48	.0055	1.5472	-.0386	.0015	.2506
	(.9483)	(.9080)*	(-1.7270)*	(4.1158)***	(.4435)

Appendix B (cont'd).

	α	β	γ	σ_{ε}^{2}	σ_{β}^{2}
49	.0059	-.8749	.0422	.0009	.2909
	(1.2880)	(-1.3223)	(2.2935)**	(3.0689)***	(.6288)
50	-.0007	2.7706	-.0218	.0017	4.3081
	(-.1051)	(2.2132)**	(-.5937)	(1.7071)*	(2.8774)***
51	.0014	2.7060	-.0528	.0010	1.1397
	(.2686)	(3.3734)***	(-2.2980)**	(2.5902)***	(2.0131)**
52	.0172	2.0201	.0016	.0024	5.6172
	(2.0421)**	(1.3776)	(.0381)	(2.8043)***	(4.2813)***
53	.0049	-.3129	.0478	.0012	4.0990
	(.7974)	(-.2767)	(1.4266)	(1.1776)	(2.7188)***
54	-.0132	1.3231	-.0104	.0024	-1.0067
	(-2.1256)**	(1.1482)	(-.4133)	(2.3978)***	(-.6601)
55	.0073	1.6380	-.0402	.0008	.7613
	(1.6082)	(2.3294)**	(-2.0102)**	(2.2041)**	(1.3797)*
56	.0015	-.3747	.0206	.0005	.5029
	(.4005)	(-.6621)	(1.2806)	(2.2169)**	(1.4297)*
57	.0057	1.6769	.0179	.0012	2.3935
	(.9707)	(1.6728)*	(.6172)	(2.3736)***	(3.0506)***
58	.0006	1.1948	-.0021	.0011	2.2284
	(.1020)	(1.2497)	(-.0737)	(2.2710)**	(3.0464)***
59	-.0025	1.1585	.0060	.0007	.2057
	(-.6521)	(2.0725)**	(.3833)	(3.0853)***	(.6251)
60	.0019	.4479	.0029	.0009	.2771
	(.4161)	(.6785)	(.1591)	(2.7782)***	(.5401)
61	.0086	.1821	.0160	.0011	.6409
	(1.6729)*	(.2365)	(.7392)	(3.4628)***	(1.343)*
62	-.0066	4.1524	-1.1105	.0018	1.0142
	(-.9881)	(4.2071)***	(-3.9871)***	(2.1541)**	(.7772)
63	.0052	1.3032	.-.0242	.0006	-.2502
	(1.8344)*	(2.6799)***	(-2.2620)**	(3.4730)***	(-1.0073)
64	.0052	.4002	-.0136	.0017	.2953
	(.8532)	(.4657)	(-.5742)	(2.1170)**	(.2407)

Appendix B (cont'd.)

	α	β	γ	σ_{ε}^{2}	σ_{β}^{2}
65	.0099	-.7636	.0625	.0020	.2645
	(1.4995)	(-.8216)	(2.4465)**	(3.1114)***	(.2633)
66	.0104	-.3065	.0396	.0011	.2261
	(2.0948)**	(-.4356)	(2.0390)**	(3.0103)***	(.3977)
67	.0081	-1.0451	.0712	.0043	3.5755
	(.7783)	(-.6531)	(1.5697)	(1.2073)	(.6541)
68	-.0022	-.3774	.0676	.0021	1.0581
	(-.3068)	(-.3612)	(2.3080)**	(3.4466)***	(1.1317)
69	-.0026	1.9428	-.0334	.0019	1.5045
	(-.3753)	(1.8333)*	(-1.1134)	(2.5612)***	(1.3077)*
70	.0037	.2407	-.0123	.0012	.1651
	(.7344)	(.3373)	(-.6277)	(2.1701)**	(.1956)
71	-.0006	1.9285	-.0315	.0014	-.1355
	(-.1205)	(2.7715)***	(-1.6782)*	(3.6698)***	(-.2368)
72	.0020	.1854	-.0054	.0001	-.0266
	(1.9073)*	(1.3963)	(-1.4770)	(2.6853)***	(-.5647)
73	-.0016	-.6628	.0502	.0036	-.6214
	(-.1964)	(-.6164)	(1.7401)*	(2.1022)**	(-.2391)
74	-.0005	-.0325	.0158	.0011	-.1340
	(-.1111)	(-.0529)	(.9528)	(3.4923)***	(-.2786)
75	.0043	1.4598	.0168	.0017	.5995
	(.5995)	(1.1698)	(.4589)	(1.4409)*	(2.3108)**
76	-.0824	1.6217	.2063	.0505	-28.3133
	(-3.2321)***	(.4309)	(7.9871)***	(3.0670)***	(-1.1173)
77	-.0044	1.4618	-.0204	.0006	.3750
	(-1.1098)	(2.4881)**	(-1.2340)	(3.1694)***	(1.2106)
78	.0113	-.9708	.0974	.0041	.5056
	(1.2087)	(-.7399)	(2.7019)***	(3.9104)***	(.3163)
79	.0020	.6293	-.0028	.0012	.3306
	(.3849)	(.8385)	(-.1350)	(4.1949)***	(.7413)
80	.0010	1.9918	-.0222	.0016	.1421
	(.16452)	(2.4580)**	(-.9990)	(3.8947)***	(.2266)

Appendix B (cont'd.)

	α	β	γ	σ_{ε}^2	σ_{β}^2
81	.0037 (.6260)	1.2825 (1.6235)	-.0347 (-1.6322)	.0019 (3.8265)***	-.2771 (-.3712)
82	.0080 (.7828)	1.0060 (.7458)	.0007 (.0200)	.0059 (2.4936)***	-1.2328 (-.3402)
83	.0025 (.7404)	1.5756 (3.2202)***	-.0369 (-2.7170)***	.0005 (3.1726)***	.1452 (.5826)
84	.0025 (.5985)	-.0431 (-.0712)	.0201 (1.1918)	.0007 (2.3425)***	.3084 (.6425)
85	-.0006 (-.1174)	2.1156 (3.2565)***	-.0399 (-2.2699)**	.0012 (4.4594)***	-.0781 (-.1960)
86	-.0001 (-.0177)	.1337 (.1940)	.0050 (.3302)	.0012 (1.8866)**	-.5370 (-.5560)
87	.0049 (.9073)	2.3648 (3.0957)***	-.0519 (-2.4687)**	.0014 (3.9089)***	.1883 (.3503)
88	.0005 (.0658)	1.7822 (1.7447)*	-.0299 (-1.0631)	.0024 (3.6698)***	.3698 (.3647)
89	.0048 (.7031)	-.6360 (-.6966)	.0186 (.7573)	.0025 (3.8522)***	-.3917 (-.3920)
90	.0025 (.4134)	1.1711 (1.4049)	-.0129 (-.5680)	.0018 (3.4834)***	.0281 (.0359)
91	.0017 (.3559)	.1825 (.2891)	.0002 (.0138)	.0015 (4.5684)***	-.4116 (-.8235)
92	.0133 (1.6186)	1.7727 (1.5483)	-.0499 (-1.5901)	.0031 (3.2038)***	.3414 (.2274)
93	.0013 (.1513)	.6817 (.5619)	.0122 (.3643)	.0034 (3.0437)	.4886 (.2815)
94	-.0028 (-.7125)	-.4225 (-.7565)	.0269 (1.7422)*	.0007 (3.7736)	.1770 (.6408)
95	.0105 (3.0345)***	.7426 (1.4670)	-.0215 (-1.5198)	.0005 (3.1015)***	.2062 (.8033)

Appendix B (cont'd.)

	α	β	γ	σ_{ε}^{2}	σ_{β}^{2}
96	.0058	.4930	-.0025	.0004	.5663
	(1.8518)*	(.9579)	(-.1672)	(2.6425)***	(2.8035)***
97	.0359	.8479	-.0762	.0050	-3.1951
	(2.3235)**	(.7806)	(-2.1316)**	(3.3205)***	(-1.3807)
Average		1.0107	-.0155		

*** = significant at 1% level
** = significant at 5% level
* = significant at 10% level

Appendix C

Coupon Rate and Maturity Date for Convertible Bonds with Significant Time Trend

Company No.	Company Name	Coupon Rate	Maturity Date
1	Alexander's Inc.	5.55	96
2	Allegheny Ludlum Steel	4.05	81
4	Aluminum Co. of America	5.255	91
13	Bobbie Brooks, Inc.	5.255	81
17	Chris-Craft Industries, Inc.	6.05	89
19	Computer Sciences Corp.	6.05	94
20	Cooper Laboratories, Inc.	4.55	92
36	Great Northern Wekoosa, Corp.	4.255	91
41	International Minerals and Chemical Corp.	4.05	91
42	International Silver Co.	5.05	93
44	Kirsch Co.	6.05	95
47	Maryland Cup Corp.	5.1255	94
48	Mohawk Data Sciences	5.55	94
49	National Can Corp.	5.05	93
51	North American Phillips Corp.	4.05	92
55	Parker-Hannifin Corp.	4.055	92
62	St. Regis Paper Co.	4.8755	97
63	Standex Intl. Corp.	5.05	87
65	Stores Broadcasting Co.	4.55	86
66	Sundstrand Corp.	5.05	93
68	Tesorro Petroleum Corp.	5.255	89
71	United Brands Co.	5.55	94
73	White Motor Corp.	5.255	93
76	Wyly Corp.	7.255	95
78	Zapata Corp.	4.755	88
83	DPF, Inc.	5.755	92
85	Fischer and Porter Co.	5.55	87
87	Grow Chemical Corp.	5.255	87
94	Ryan Homes, Inc.	6.05	91
97	Work Wear Corp.	4.755	85